POLICIES GOVERNING

PREPARATION AND SUBMISSION

OF

PLANS AND SPECIFICATIONS

FOR

MUNICIPAL SEWER SYSTEMS

AND

SEWAGE TREATMENT PLANTS

PREPARED

BY

DIVISION OF PUBLIC HEALTH ENGINEERING

STATE DEPARTMENT OF HEALTH

DES MOINES, IOWA

POLICIES GOVERNING PREPARATION AND SUBMISSION OF PLANS AND SPECIFICATIONS FOR MUNICIPAL SEWER SYSTEMS AND SEWAGE TREATMENT PLANTS

FOREWORD

The purpose of this bulletin is to establish policies governing preparation and submission of plans and specifications for municipal sewer systems and sewage treatment plants as a guide for municipal officials and designing engineers. It is not intended that these policies be considered as absolute minimum standards. Deviations will be permitted if unusual local conditions exist, in which case the plans and specifications should be accompanied with an explanation for such changes.

It is hoped that this bulletin will facilitate the preparation, submission, and review of plans and specifications. The policies herein set forth will be changed and expanded from time to time to meet changing standards which are considered to be good public health engineering practice.

May, 1943

TABLE OF CONTENTS

LAW DELEGATING POWER OF APPROVAL

The State Department of Health has been charged with certain "Powers and Duties" by law, including supervision of the installation and operation of public sewer systems and public sewage treatment plants:

Code of Iowa, 1939, Section 2191, Powers and Duties

"7. Make inspections of the public water supplies, sewer systems, sewage treatment plants, and garbage and refuse disposal plants throughout the State, and direct the method of installation and operation of the same."

DEFINITIONS

Sanitary Sewer System -

A sanitary sewer system will be considered within this bulletin as any sewer system which carries exclusively domestic or industrial wastes, or both.

Plans and specifications for all sanitary sewer systems or extensions to existing systems shall be submitted to the State Health Department for review and approval before construction is started.

Combined Sewer System -

A combined sewer system will be considered within this bulletin as a sewer system which carries both sanitary sewage and/or industrial wastes and storm water or drainage.

Storm Sewer System -

A storm sewer system will be considered within this bulletin as any sewer system which carries only storm water surface drainage or other clean water and does not carry any domestic or industrial wastes.

Plans and specifications for storm sewer systems ordinarily need not be submitted to the State Department of Health for review and approval.

Sewage Disposal -

Sewage disposal will be considered within this bulletin as any treatment plant or treatment process of domestic or industrial wastes; also, any other means of disposing of domestic or industrial wastes, such as ponding, irrigation, etc.

Plans and specifications for all sewage treatment or disposal methods shall be submitted to the State Department of Health for review and approval before construction or disposal is started.

PROCEDURE FOR SUBMITTING PLANS AND SPECIFICATIONS FOR REVIEW AND APPROVAL

Requests for the approval of proposed projects should be accompanied by a report describing the project, detailed plans, and complete specifications.

All proposals should be submitted by the local municipal officials or an authorized agent. Plans and specifications must be prepared in accordance with the Engineers License Law of Iowa.

In the case of sewage disposal, a complete preliminary report should be submitted for review before final detailed plans are started.

For sewers in a municipality where standard specifications are on file with the State Department of Health, the specifications for extension may be incorporated in the engineering report or in the plans by reference.

All preliminary reports, plans, and specifications shall be submitted in duplicate. One copy of the approved reports, plans or specifications, will be returned to the sender and one copy of each will be retained for the files of the State Department of Health. Additional copies as are needed by the owner may be submitted for approval.

Plans should be blue prints, black or color line prints, or other reproductions of equal quality. Tracings will not be accepted or approved.

All prints should be legible and completely detailed for correct interpretations. Standard sheet pages are suggested for filing convenience, preferably in multiples of 8½"x 11", with larger sheets 22"x 36".

The State Department of Health further requests that preliminary reports, plans and specifications be submitted in advance of deadline dates so that thoroughness of review may be executed. Ordinarily, the State Department of Health retains the right to reserve ten days for reviewing reports, plans, or specifications after the date received.

All approvals by the State Department of Health will be considered to be effective for a period of two years only subsequent to the date of approval. If construction on an approved project proposal is not started within two years after the date of approval, the plans and specifications must be resubmitted for review and approval.

LIMITS OF REVIEW AND APPROVAL

Generally speaking, the review and approval of plans and specifications by the State Department of Health will be limited to consideration of functional and sanitary features of design of structures and equipment. The Department will not make a detailed check of structural design except such structural features which may affect the public health and safety or the health and safety of the operating staff and the functional use for which the plant is designed.

The Department also reserves the right to review the economics of the general plan of treatment as compared with other possible plans of treatment.

The Department will base its approval upon design data as submitted by the engineers and can take no responsibility for the correctness of such data.

Approval of plant site does not imply a guarantee against litigation which might result from the operation of the plant. The Department will base its approval of a site upon the assumption that the plant will be properly maintained and operated, will not be overloaded and that every possible precaution will be taken to control nuisance conditions. Furthermore, approval of a site will be predicated upon the assumption that the owner has a legal right to utilize the site shown on the plans.

APPROVAL OF NEW PROCESSES

The State Department of Health encourages the development and use of new processes which have been thoroughly tested and found satisfactory in full-scale plant operation. In reviewing plans and specifications, judgment and comment must necessarily be predicated upon experience and standard practice. If new processes are proposed incorporating deviations from standard practice, proof of merit of the processes must be provided together with a bonded guarantee of performance. It is the duty of the State Department of Health, as well as the designing engineer, to thoroughly investigate the merits of new processes before recommending their installation.

Methods of sewage disposal and treatment processes are continually changing with additional knowledge and experience. Therefore, approval of plans and specifications by the State Department of Health does not infer that recommendations for alterations or additions will not be offered at some later date when conditions change, or methods of sewage treatment are improved.

CONTENTS OF PROJECT OR PRELIMINARY REPORT

Project or preliminary reports should be prepared for all proposed sewerage installations including new systems and extensions to existing systems. The report should include all pertinent data upon which the design is

based. The State Department of Health in reviewing reports will consider the following items as pertinent design data:

Sewer System -

1. Statement of the general problem.
2. Present and future areas to be served.
3. Present and estimated future population to be served.
4. Existing sewer systems--
   a. Description of existing system--combined or separate, condition of sewers, grades, manholes, infiltration, etc.
   b. Description of water supplies available, including chemical characteristics.
   c. Representative chemical analysis of sewage.
   d. Quantity of sewage, including measurements of day flow, night flow, maximum hour, minimum hour, and maximum infiltration.
   e. Industrial waste to be treated, including data in "c" and "d" above plus seasonal fluctuations.
5. For new sewer systems, prepare estimates on all the items listed in "2", "3" and "4" above.

Treatment Plant -

1. Degree of treatment to be provided based upon character of receiving stream. The degree of treatment should be predicated upon:
   a. Stream discharge available for dilution.
   b. Use of stream below sewer outlet--swimming, natural ice harvesting, water supply, etc.

c. Physical characteristics of stream--backwater pools, rapids, dams, period of ice coverage, etc.

2. Description of sewage disposal plant sites available, including distances to residence, highways, and industries, prevailing wind directions, high water or flooding conditions, accessibility, etc.

3. Sewage flow diagram of hydraulic gradient through the treatment plant.

4. Comparison of types of treatment processes considering--

   a. Efficiency.

   b. Flexibility of operation.

   c. Adaptability to enlargement or expansion.

   d. Estimate of construction cost.

   e. Estimate of operation cost.

5. Engineer's recommendation of type of treatment, including reasons for recommendation.

6. Bases of design of recommended type.

7. General maps showing location and layout sketches, including control point elevations on treatment units.

8. Estimates of cost and method of financing.

   a. Construction.

   b. Operation and maintenance.

The State Department of Health urges that preliminary reports containing pertinent data outlined above be submitted for review before detailed plans and specifications are prepared. This procedure will facilitate the review of subsequent plans and specifications and also afford an opportunity to discuss the proposed design before final details are started.

General or blanket approval will not be given any treatment process. Each proposed installation will be considered separately. Circumstances are

rarely the same and, therefore, consideration must be given individually.

SEWER PLATS AND PROFILES

A plat and profile of all new sanitary sewer systems or extensions to existing systems should be submitted to the State Department of Health for review and approval. A new sewer system should be comprehensive, including future extensions. If a map of the comprehensive sewer system has been previously submitted, a plat and profile of the proposed extension is sufficient.

A. Sewer plats should be accurate, detailed, and legible, and the following data should be shown:

1. Corporate limits of the municipality or the boundaries of the sewer district.
2. Street and lot lines, and building locations.
3. Water courses, including high and low stage elevations.
4. All sewer lines, present and future.
   a. Distance between manholes.
   b. Elevations of sewer inverts, ground surface, and established grade line.
   c. Sizes, grades, and direction of flow.
5. Location of sewage disposal plant site and outfall sewer.
6. Contour lines at plant site with contour intervals of two feet or less.
7. Location of wells within 200 feet of any sewer line.
8. Location of water mains.
9. Location of railroad crossings.
10. A suitable title with the name of the municipality, the scale, datum plane, north point, date, and engineer's name and Iowa license number.

B. Sewer profiles should include the following:

1. Plat for portions of profile shown.
2. Profile of existing ground and of established grade line.
3. Location of buildings with basement elevations.
4. Profile of sewers.
5. Manhole elevations--top and invert.
6. Distance between manholes.
7. Grades.
8. Pipe sizes.

SEWER DESIGN DATA

Sanitary sewers should be designed to remove house sewage, industrial waste, and basement drainage only. Storm water, including street and roof drainage, should be discharged elsewhere. Cooling water and air conditioning water should be kept out of the sanitary sewer if possible.

Specifications should include the type of jointing construction so as to reduce the amount of infiltration to a minimum. Limits of infiltration in gallons per foot or mile of sewer per day, should be specified because of the direct effect upon the disposal plant design capacity and efficiency.

The following sewer design items will be used as a basis for reviewing new project proposals where ordinary conditions exist:

1. Separate sanitary sewers will be required on all new projects and on extensions to existing separate sanitary systems. Combined sewer extensions will be approved only in unusual cases where the existing sewer is combined and where future separation of storm and sanitary sewage is deemed not feasible,
2. Sanitary sewer capacity should be two to three times the estimated future wet weather flow.

3. Combined sewer capacity should be three to five times the estimated future wet weather flow.

4. Grades on sanitary sewer should be provided to give velocities of at least 2.0 feet per second flowing one-half full whenever possible. If flatter grades are used, a statement giving reasons for the flatter grades and plans for special maintenance should be included. For vitrified clay and concrete tile laid with smooth joints using a coefficient of roughness n = .013 in Kutter's formula, 2.0 feet per second velocity requires grades as listed below. These standards for sewer pipe grades do not apply to outfall sewers from treatment plants which normally carry treated sewage with little or no settleable solids, in which cases lower velocities and flatter grades may be used.

Size of Pipe	Slope per 100 feet
8 inch	.40 feet
10 "	.30 "
12 "	.22 "
15 "	.16 "
18 "	.12 "
24 "	.08 "

5. Sewer manholes are primarily to facilitate maintenance and operation of a sewer system and, therefore, should be strategically located. In general, a manhole should be watertight, easily accessible, and have a minimum inside bottom diameter of four feet.

Manholes should be located at--

a. Every break in grade or alignment.

b. Every street (or alley) intersection.

c. Maximum distances of 400 feet for sewers eighteen inches in diameter or less, and 500 feet for larger sewers.

Manhole inverts should be lined with a half tile or molded to conform to a half tile in shape and smoothness and laid to a grade at least as great as that of the sewer above. Preferably a minimum drop of .05 feet should be allowed through a manhole.

6. The construction of sewers should be such that the full area of the sewer is visible from manhole to manhole.
7. Sewer laying and jointing to be such as to guarantee infiltration of less than 12,000 gallons per mile of sewer (eighteen inches diameter or less).
8. Inverted siphons should include at least two pipe lines of such size and grade to maintain at least three feet per second velocity under all conditions of flow. Control manholes should be provided at both ends of the inverted siphon designed to facilitate rodding and flushing each pipe line.
9. Earth loads on the sewer pipe should not exceed the cracking strength of the sewer pipe.

SEWAGE LIFT STATIONS

Under ordinary conditions, sewage lift stations should be used only where gravity systems are impracticable. Where installed, the design of the lift station should minimize the possibility of mechanical failures and should facilitate accessibility.

The lift station should include a wet well for receiving the sewage and an entirely separate dry well for the pumping equipment. Separate entrances

should be provided into the wet well and dry well. The wet well should be relatively small for a short holding period, which should not exceed thirty minutes at average sewage flow.

Adequate ventilation should be provided for both the wet well and dry well. For lift stations more than ten feet below the surface of the ground, positive ventilation by means of fans or blowers should be provided.

Pumps for raw sewage should be preceded by a bar or basket screen unless special non-clogging type of pumps are specified. All sewage screens should be readily accessible and easily cleaned.

The bottom of the wet well should slope sharply to the suction pipe of the pump to minimize the accumulation of sewage solids. Slopes of 1.5 vertical to 1.0 horizontal are recommended.

The dry well should be of sufficient size to accommodate the pumps, motors, valves, piping, etc., without congestion with the view of future repair and maintenance. The floor should slope to a sump equipped with a sump pump or other means of ejection.

At least two pumps should be installed with balanced capacity for minimum detention in the wet well and combined capacity at least equal to the maximum wet weather rate of flow. The pumps should be of a type designed for pumping sewage and should be set below the high water level in the wet well. Further, the pump setting should be such that the impellers are readily accessible for cleaning and repair.

For lift stations pumping sewage directly into the treatment plant, the selected pump capacities should include one pump that will operate almost constantly. Other pumping units should automatically go into operation whenever the volume of sewage flow exceed the capacity of the first pump. The pump suction and discharge pipe should be equipped with suitable check and gate valve arrangement to facilitate repairs. Ordinarily, the pump suction and discharge pipe should not be smaller than four inch diameter.

Potable water supply lines shall not be directly connected to a sewage pump, suction or discharge line for priming, flushing, lubrication or any other purposes.

PLANS FOR SEWAGE TREATMENT PLANTS

Plans of a sewage treatment plant showing details of layout and construction should include the following items:

1. General layout map of municipality or district served.
2. A plat detailing the location of the treatment plant units and treatment plant site.
3. Detail plan, elevation, and sectional views of all treatment units sufficient for correct interpretation of proposed construction.
4. Complete plan of outside piping for all the sewage treatment plant units.
5. Sewage flow diagrams in plan and elevation, including the hydraulic gradient through the plant.
6. Detailed diagrametic layout of the sludge digester heating system.
7. A plat and profile of the outfall sewer, including the outfall bulkhead and showing high and average stream elevations.

DEGREE OF TREATMENT

The degree of treatment should be determined by the size and character of the receiving stream. The size of stream as related to minimum flows that may be expected and the character of stream as related to turbulence, quiesence, etc., which are pertinent to reaeration directly affecting the ability of the stream to receive sewage. If stream flow records are available,

a probability curve of stream flows should be formulated to assist in determining the degree of treatment that should be provided. Ordinarily, not more than 4.0 parts per million of dissolved oxygen should be assumed as available in the receiving stream for satisfying the B.O.D. of the sewage. Also, at least 4.0 parts per million of dissolved oxygen should be the minimum assumed necessary for fish life.

The State Department of Health will require at least primary sewage treatment in all cases, regardless of the size of the receiving stream, to remove settleable solids and prevent the formation of sludge banks immediately below the sewer outlet. Where the receiving stream below the sewer outlet is used for recreational purposes, source of public water supply or other public health considerations, special attention should be given to providing a high degree of purification with provision for disinfection. Further, where the receiving stream has periods of practically no flow, high degree of treatment will be necessary with provisions for disinfection. In such instances, the plant effluent should be equivalent to that of activated sludge or sand filters with a high degree of nitrification to produce a stable effluent.

As a general guide of what degree of treatment may be expected from various plant units treating domestic sewage, the following efficiencies which may be expected are suggested:

Clarification - no chemicals.

1. B.O.D. reduction 25-35%.
2. Suspended solids reduction 40-50%.
3. Settleable solids reduction 90-95%.

Flocculation and clarification - no chemicals

1. B.O.D. reduction 40-50%.
2. Suspended solids reduction 50-75%.
3. Settleable solids reduction 95-99%.

Chemical precipitation.

1. B.O.D. reduction 50-75%.
2. Suspended solids reduction 70-90%.
3. Settleable solids reduction 95-99%.

Chemical precipitation followed by rapid sand filter or magnetite filter.

1. B.O.D. reduction 60-85%.
2. Suspended solids reduction 80-95%.

Rock filters preceded and followed by clarification and depending upon filter loadings.

1. B.O.D. reduction 50-85%.
2. Suspended solids reduction 80-90%.

Activated sludge.

1. B.O.D. reduction 85-95%.
2. Suspended solids reduction 85-95%.

Intermittent sand filters.

1. B.O.D. reduction 90-95%.
2. Suspended solids reduction 85-95%.

SEWAGE TREATMENT PLANT SITE

In selecting a sewage treatment plant site, the following items should be considered:

1. The plant should be located at a point where all the sewage may be directed for treatment, preferably downstream from the municipality.
2. The plant site should be isolated from all occupied buildings, particularly residences. Ordinarily, 1,200 feet from a residence should be considered a minimum distance for small plants, with greater distances for larger plants.

3. Adequate land area should be obtained for convenient arrangement of plant units and for reasonable future expansion.
4. A permanent roadway should be provided for year-round use to the treatment plant.
5. The plant should be built above ordinary high water or suitable flood protection should be provided.

DESIGN OF SEWAGE TREATMENT PLANT UNITS

PUMPS (For details see section on sewage lift stations)

1. At least two pumps should be provided for balanced capacity to provide a minimum detention in the wet well.
2. Combined pump capacity must be equal to or greater than the maximum wet weather flow.
3. Pumps installed in dry wells with suction to wet wells should be arranged to remove practically all solids at each pumping cycle.
4. Dry well should be adequately ventilated.
5. Dry well and pumps should be easily accessible to facilitate maintenance and repair.

SCREENS

1. Bar screens or racks should be provided for the protection of the pumps.
2. Net area openings for non-mechanical screens should be at least 150% of the area of the incoming sewer.
3. Mechanical screens with shredding device for screenings are desirable.
4. In the case where screenings are not returned to the sewage provision should be made for the convenient

removal of screenings from the screen chamber.

5. Provision for sanitary disposal of screenings by burial, incineration, or return to sewage should be made.
6. Screen chambers and screens should be easily accessible to facilitate maintenance and repair.

GRIT CHAMBERS

In all installations treating storm sewage and in installations treating sanitary sewage which contains a considerable amount of grit, grit chambers should be provided as follows:

1. Multiple channel with flow regulation device to maintain velocity of approximately 1 ft./sec. and detention of at least 1 min., or
2. Mechanical grit removers with velocity less than 1 ft./sec. Consideration should be given the type of mechanical equipment and its location to facilitate "all weather" operation.
3. Easily accessible to facilitate maintenance and repair.

SETTLING TANKS

1. Septic tanks - not approved except for residential and other very small installations.
2. Imhoff tanks - (contraindicated for treatment of creamery and other acid-producing industrial wastes.)
   a. Flowing through chamber designed for two to three hours' detention at average flow and 600 gallons/sq.ft./24 hours overflow rate at average dry weather flow. The maximum wet weather overflow rate should not exceed 1,000 gal./sq.ft./24 hours.
   b. Flowing through chamber bottom slopes at least 1.4 vertical to 1.0 horizontal.

c. Slot opening six inch minimum with at least eight inch effective overlap.

d. Inlets arranged to obtain equal distribution across the width of the flowing through chamber and to prevent short circuits.

e. Overflow weirs should be straight-edged and adjustable. In circular tanks, the weir should extend around the entire periphery of the tank. In rectangular tanks, the weir length should approximate the circumference of a circular tank of the same area.

f. Sludge digestion capacities: (Assuming effective capacity starting eighteen inches below the slot overlap.) Northern half of state 3.5 cu.ft./capita, southern half of state 3.0 cu.ft./capita.

g. At least five feet differential head between the water level in the Imhoff tank and the surface of the sludge drying bed for gravity removal of sludge should be provided.

3. Mechanical clarifiers.

a. The detention and overflow rate should be the same as for Imhoff tank above.

b. Minimum horizontal distance of travel ten feet. In place of small diameter circular clarifiers, straight-line tanks are encouraged.

c. Inlets for straight line clarifier should be the same as for the Imhoff tank above. For circular tanks with radial flow inlets should be so baffled as to destroy inlet velocity and to secure uniform distribution of flow.

d. Overflow weirs should be straight-edged and adjustable. In circular tanks, the weir should extend around the entire periphery of the tank. In rectangular tanks, the weir length should approximate the circumference of a circular tank of the same area.

e. A scum trough located immediately ahead of the outlet troughs, discharging into a scum sump which is connected to the sludge pump for pumping the scum to the digester, is encouraged and must be provided where the sewage has an abnormal grease content.

4. Plain clarifiers - use discouraged for primary settling, however, are satisfactory for secondary settling under certain controlled conditions.

a. Detention and overflow rate same as noted above for Imhoff tank and mechanical clarifiers. (Hoppers are not included in computing detention.)

b. Inlet and outlet weirs same as Imhoff tank and mechanical clarifiers.

c. Bottom slopes at least 1.4 vertical to 1.0 horizontal.

5. Flocculators

Mechanical flocculators are particularly encouraged for combined domestic and industrial sewage to obtain greater solids removal in the primary tank and also provide for use of chemicals during periods of plant overload.

a. Detention 40-60 minutes at average dry weather flow.

b. Inlet to obtain equidistribution across the width of the tank.

c. Outlet of such size and arrangement to prevent breaking up floc particles with velocities not exceeding 1.5 feet per second.

d. Mechanical facilities to maintain 0.5 to 1.5 feet per second velocity through the flocculator. Variable speed mechanism to provide these velocities should be included.

e. Fillets and baffles properly located to maintain adequate velocities and prevent deposition of solids within the flocculating basin.

SEPARATE SLUDGE DIGESTION TANKS

1. Capacities

a. No rule of thumb capacity can be given for digesters where industrial wastes are to be treated because of the nonuniformity of sludge resulting from such wastes. In such cases capacities should be carefully computed from data collected on solids content of the sewage. In larger municipal installation design of digesters should likewise be based upon analytical data.

b. In smaller installations where only domestic sewage is to be treated the following rule of thumb capacities may be used in the absence of analytical data. In computing effective capacity three feet of depth below the overflow shall be allowed for supernatant liquor.

(1) Heated digesters with trickling filter or sand filter installation with air drying of sludge - 3 cubic feet per capita.

(2) Heated digesters with trickling filters or sand filters with provisions for continuous sludge dewatering or drying or storage - 1½ cubic feet per capita.

(3) Heated digesters with activated sludge approximately twice the above capacities.

(4) Unheated digesters will not be approved except for very small installations. Approximately double the capacities indicated under 1, 2, and 3 will be required.

2. Multiple sludge digestion tanks arranged for stage digestion are recommended for flexibility in operation in plants large enough to warrant the cost. In smaller plants an unheated sludge storage tank in addition to the heated digester is encouraged.

3. Provisions for sludge recirculation within the digester and for applying chemicals should be made.

4. Supernatant draw-off lines at four or more elevations, the lowest being in the lower third of the tank, should be provided. Provisions for sampling supernatant should be made with special provisions for ventilating and cleaning the sampling basin.

5. Insulation of digester walls to conserve heat is recommended.

6. All sludge piping should be laid without sharp bends or other restrictions which might retard flow. The size should be such as to maintain self cleansing velocities with 4" pipe recommended as the minimum practical size. Taps for air or water connections at critical points should be provided to facilitate cleaning.

7. Digester covers should be provided with a positive pressure and vacuum relief and with convenient manholes provided with gas-tight covers for inspection and repair.
8. Fixed cover digesters shall be provided with a positive trapped overflow at an elevation which will maintain the liquid level at the bottom of the gas collection dome.
9. All heating coil piping fittings and support brackets within the digester should be either of cast or wrought iron throughout. In any event dissimilar metals should be avoided to minimize galvanic action.

GAS BURNING AND SLUDGE HEATING APPURTENANCES

In the collection and burning of sludge gas, the following items should be given consideration:

1. Provide a boiler of adequate capacity for heating requirements.
2. Two or more gas burner units are suggested so that a suitable range of rate of gas burning is available.
3. The boiler should be provided with an automatic control device so that when the boiler temperature reaches an adjustable, predetermined temperature, the gas supply line to the burners will be shut off.
4. Provide an automatic control to shut off the main gas supply line if the pilot burner is not burning.
5. Provide an automatic control to shut off the main gas supply line in the event electrical current supply fails.
6. Include an automatic control for the gas burners to maintain temperatures of at least 180 degrees Fahrenheit within the boiler to minimize boiler corrosion.

7. Provide a suitable adjustable automatic mixing valve for mixing boiler water with return water to obtain temperatures in the mixed water within a range of approximately 90 degrees Fahrenheit to 150 degrees Fahrenheit. Ordinarily, temperature of the water within the heating coil in the digester should not exceed 135 or 140 degrees Fahrenheit because of possible "cooking" or "baking" of sludge on the coil and reducing the effectiveness of heat transfer.
8. Include a by-pass around the mixing valve in "7" above with proper valves for manual mixing and temperature control of water to the digester.
9. Thermometers should be provided on the boiler, mixed water to the digester, and return water from the digester, and located at readily accessible points. Automatic temperature recorders are encouraged for larger plants.
10. Insulation of hot water lines to and from the digester is encouraged to minimize heat losses.
11. Drip traps and flame traps should be provided on the main gas line to the boiler and the gas line to the waste gas burner.
12. Provide slope toward the control building on the gas line from the digester and on the gas line to the waste burner for the drainage of condensate.
13. A waste gas burner located at least twenty-five feet from any building or structure is encouraged.
14. The hot water heating system should not be cross-connected to any drinking water supply. For an "open system," the water make-up supply pipe should terminate at least two

pipe diameters above the rim of the open expansion tank. For a "closed system," a small pump discharging directly into the system and taking suction from an open non-cross-connected supply tank should be provided.

15. The location of gas burning equipment below grade in basement is discouraged because of difficulty in providing adequate ventilation and excessive rusting of the equipment.

SLUDGE DRYING BEDS - OPEN AIR

1. Provide at least 1.0 square foot per capita for rock and sand filters, and 1.5 square feet per capita for activated sludge.
2. Underdrains not more than ten feet apart are encouraged and should be surrounded with clean gravel extending at least nine inches above the top of the tile.
3. Vents at the end of each underdrain are encouraged.
4. At least twelve inches of clean sand above the gravel should be used. The sand should have an approximate effective size of .5 mm., and a uniformity coefficient not greater than 4.0.
5. Dividing the bed into several small units is encouraged for flexibility of operation.
6. Plank or concrete slab driveways are encouraged to facilitate removal of dried sludge.

INTERMITTENT SAND FILTERS

Intermittent sand filters will produce an excellent effluent if not overloaded, operated continuously, and given regular operative attention. Sand filters, however, are contraindicated

for secondary treatment of industrial wastes, such as creamery, cannery, packing house, etc. In the treatment of industrial wastes, the sand filter may be used only as a final or polishing treatment if preceded by primary clarifier, rock filter, and secondary clarifier, or equivalent.

The following items should be considered in the design and layout of sand filters:

1. Maximum population loading, or population equivalent, 1,800 persons per acre per day, or water loading 150,000 gallons per acre per day. Short water overload periods up to 50% may be applied.
2. Underdrains spaced not greater than ten feet apart and surrounded with clean gravel extending at least twelve inches above the top of the tile.
3. Provide vents at both ends of each filter underdrain line extending at least six inches above the sand surface.
4. The filter should include at least twenty-four inches (depth) of clean sand--effective size .3 to .5 mm. and uniformity coefficient not greater than 2.5. Exceptions may be made where local sand which does not meet these specifications as to size and uniformity may be obtained at appreciably lower cost, however, greater filter area will be required.
5. The dosing tank should be of such size and the siphon of such drawing depth that one and one-half to three inches of sewage will be dosed on the filter.
6. The capacity of the dosing tank should be such that two to four doses may be applied to each sand filter each day.

7. Provide distributor tile or conduit properly located to obtain equal distribution over the sand area.
8. Particular attention should be given to locating sand filters above flood water. Flood water backing up into underdrains is likely to close the underdrains and necessitate extensive repair.

TRICKLING (ROCK) FILTERS

Research and experience indicate the rated capacity of trickling filters may be influenced by chemical characteristics of sewage treated, filter media, rock size, filter depth, filter ventilation, dosing cycle, temperature, B.O.D. desired in effluent, nitrification desired through filter, etc. Where continuous high degree of treatment is required by the receiving stream, the following items should be considered; although where adequate dilution is available, deviations will be considered.

1. Sewage should be clarified, or equivalent, to remove a greater part of the settleable solids before being applied to trickling filters. Industrial wastes, such as creamery, etc., which are low in settleable solids, may be applied directly to trickling filters without passing through primary settling tanks.
2. Filter loading should be approximately 350 pounds per acre foot. At .15 pounds of B.O.D. per capita and assuming one-third removal through the primary clarifier, the 350 pound loading is equivalent to 3,500 persons per acre foot. This loading is applicable for filters with at least seven feet of rock.
3. Filter rock depths, where practicable, should be between seven feet and nine feet where a high degree of nitrification is necessary.

4. Filter rock specifications should include rock size one and one-half to three inches with larger rock for at least one foot immediately above the underdrains.
5. Filter rock specifications should include the A.S.C.E. soundness test for twenty cycle rock. If twenty cycle rock is not available at reasonable cost and is used only as top dressing, there should be at least two feet on the filter surface, with the lower filter rock of at least ten cycle soundness.
6. The entire filter area should be underlaid with underdrains spaced not greater than twenty-four inches center to center, with sufficient carrying capacity so that the underdrains will not flow more than one-half full at maximum rate of filtration.
7. Provide ventilating galleries accessible for cleaning and rodding filter underdrains. The galleries should be on both ends of underdrains on filters exceeding seventy feet diameter or length. In smaller filters, galleries at one end with lampholes at other end for sighting, ventilation, and flushing are satisfactory.
8. The filter and filter gallery walls should be structurally designed to permit flooding the filter.
9. The filter dosing tank should be as small as possible for a minimum rest period between doses. Continuous filter dosage should be approached as nearly as possible.
10. Recirculation of final effluent during low flow periods to maintain a continuous minimum flow is encouraged.
11. Traveling, revolving, or other suitable means of distributing sewage over the filter area should be specified. The

specifications should include tolerance of filter coverage, time interval of application, etc. To facilitate winter operation, distributors with four arms or more, equipped with valves on at least two arms, should be provided.

12. The distributor manufacturer should be required to furnish the municipality and designing engineer with a performance report on the distributor after erection and final adjustment.

HIGH CAPACITY TRICKLING (ROCK) FILTERS

High capacity trickling (rock) filters will be considered where an intermediate degree of treatment will be satisfactory for the receiving stream, with approval predicated on filter loadings recommended by patentees and licensees and when a bonded performance guarantee is furnished. Each such proposal will be reviewed as an individual problem and will be considered as a new process discussed elsewhere within this bulletin.

SECONDARY CLARIFIER OR FINAL SETTLING

Secondary clarifiers or final settling tanks should follow all trickling (rock) filters. Final settling is particularly important following filters with high B.O.D. loadings.

The design bases for final settling are generally the same as for primary settling previously discussed.

Recirculation from the final settling tank back to the primary tank, to prevent long detention periods and maintain fresh conditions through the plant as well as providing a minimum flow to the filter, is encouraged.

ACTIVATED SLUDGE

The activated sludge process of sewage treatment under normal

operating conditions will produce a very high degree of treatment. Experience indicates, however, that the activated sludge process under normal operation does not have the capacity for absorbing shock loads without very measurably affecting the efficiency of treatment. Therefore, where large quantities of industrial wastes are contributed to the sewer system, activated sludge type of treatment without some sort of pretreatment to iron out the peaks is contraindicated. Further, the activated sludge type of plant for small cities and towns, where experienced operation is usually lacking, is discouraged.

In the design of activated sludge plants for treatment of domestic wastes only, the following items should be considered;

1. Primary clarification is encouraged.
2. For diffused air include--
    a. Minimum aeration period of six hours with provisions for at least 25% return sludge.
    b. Air blower capacity up to at least 2.0 cu.ft./gal. of sewage.
    c. Diffuser plate or tube area should provide for at least four cubic feet of air per square foot per minute at the maximum air blower capacity.
3. For mechanical aeration include--
    a. Minimum aeration period of eight hours with provisions for at least 25% return sludge.
    b. Arrange units to operate in series or parallel.
4. Secondary or final settling
    a. Surface loading or overflow rate not to exceed 1,000 gallons per square foot per day.

b. Minimum depth ten feet with minimum detention of 2.0 hours for average dry flow.

c. Return sludge pumps in duplicate for 10% to 50% sludge return.

d. Overflow weirs should be straight-edged and adjustable. In circular tanks, the weir should extend around the entire periphery of the tank. In rectangular tanks, the weir length should approximate the circumference of a circular tank of the same area.

DISINFECTION OF SEWAGE TREATMENT PLANT EFFLUENT

Sewage treatment plant effluent should be disinfected when discharged above areas used for swimming, ice harvesting, source of public water supply, or activities that may directly or indirectly affect public health.

If chlorine is used as a disinfectant, the dosing apparatus should be duplicate units and housed for continuous operation. The chlorine should have at least thirty minutes contact time with the sewage. Suitable equipment should be provided so as to measure the amount of chlorine used as well as determining the chlorine residual in the sewage. The chlorinating equipment should have the capacity to produce at least 0.5 p.p.m. residual after thirty minutes contact.

SEWAGE TREATMENT PLANT WATER SUPPLY

Sewage treatment plant operation is greatly facilitated by a water supply strategically accessible in and around treatment units. A water supply should be provided either by extending the local public water supply to the plant site or developing a supply at the plant. Yard hydrants, sill cocks, and inside faucets should be located at or near each building and treatment unit. Particular attention should be given to the elimination of all cross-connections with a drinking water supply, either public or private.

LABORATORY EQUIPMENT

All sewage treatment plants should be provided with at least a minimum of laboratory equipment to insure proper operation. A list of laboratory equipment should be included in the specifications, as well as incorporating space on the plans of the control building or other suitable building at the plant.

Different types of sewage treatment require different laboratory equipment for operation control. Each type of treatment should be given special consideration. As a minimum, laboratory determinations should include hydrogen ion concentration or pH, settleable solids by Imhoff cones, relative stability by methylene blue, and a small manual centrifuge for sludge pH determination. Additional equipment is encouraged for larger plants, particularly for B.O.D. determinations.

SEWAGE PLANT UNIT BY-PASSES

The sewage plant layout should include adequate control manholes and unit by-passes to facilitate maintenance and operation. Wherever practicable, each treatment unit should be provided with a by-pass around the unit to insure at least partial treatment of the sewage during periods when units must be taken out of service for maintenance or repair.

SEWAGE FLOW MEASURING DEVICES

Standard weirs, calibrated channels, Venturi meters, or other suitable flow measuring devices should be provided at some accessible point in all sewage treatment plants. Such an arrangement need not be costly and is largely a matter of planning. Automatic recording devices are encouraged particularly for larger plants.

FENCING SEWAGE PLANT SITE

The sewage plant site should be enclosed by a substantial fence, particularly surrounding all treatment units. This is for the purpose of restricting access by unauthorized persons and to avoid litigation for damage claims from injuries that might be incurred while on the treatment plant grounds.

SAFETY PRECAUTION

Every consideration should be given to the design of the sewage treatment plant for the elimination of possible asphyxiation, explosion and physical hazards in and about the plant, including first-aid kits, gas masks, and other safety appliances.